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15 January 1995

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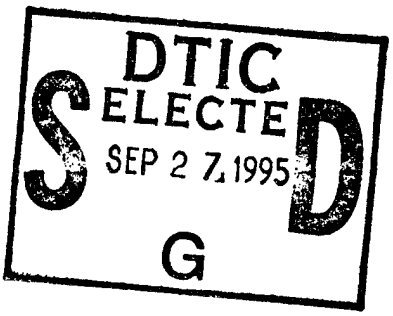

Dear Terry:

I am writing this letter to inform you about progress on our project, "Positron emission tomography studies of top-down processing" (N00014-94-1-0180). In the last quarter we have had a paper appear in *Brain*, another accepted at *Neuropsychologia*, and a third has been submitted for publication. A copy of the published paper is attached.

Ongoing studies

We have completed two studies, are re-analyzing data from a previously published PET study, and are completing another study, as summarized below.

Spatial relations encoding. We have completed our two experiments on spatial relations encoding, as summarized in previous reports. (Briefly: In the baseline, the subjects simply responded when they saw a bar with an X, which was above or below the bar; in the categorical condition, they indicated whether the X was above or below the bar; in the coordinate condition, they indicated whether the X was within .5 in of the bar.) In the first study, the stimuli were present in free view; in the second, they were exposed for less than 200 ms. The results were similar in the two studies: A large number of areas are activated in both spatial-relations tasks, but different areas are activated in the two tasks. Previous computer modeling and psychophysical work suggested that one adjusts both the scope and size of an "attention window" when performing this task, and such adjustment should require numerous processes. Indeed, many of the areas that were activated have previously been identified as playing a role in attention. We are now in the process of writing a report of these results.

Mental rotation. We have now completed essentially the same study using PET and fMRI. This study is a replication of the classic Shepard-Metzler (1971) mental rotation experiment. In the baseline condition, subjects see pairs of upright stimuli and decide if they are identical or mirror-reversals. The stimuli are composed of small blocks, arranged to form three-arm angular figures. In the experimental condition, the figure on the right side of the pair is rotated (either in depth or in the picture plane). We subtract activation in the baseline condition from the experimental condition. These results indicate activity in posterior parietal areas (in both PET and fMRI) and right dorsolateral prefrontal cortex (but only in PET), as well as several other areas; the data are still being analyzed, but appear reasonably consistent across the two methods. We also performed the same PET experiment using hands as stimuli, and now find that motor cortices--including area M1--were activated; these data are also still being analyzed.

Individual differences in top-down activation. There has recently been a controversy about whether area V1 is activated during visual mental imagery. One possible explanation for the inconsistent results some researchers have obtained is that there are marked individual differences in the ability to use stored information to modulate activation of area V1. To examine this possibility, we have reanalyzed data reported by Kosslyn et al. (1993), who asked 16 subjects to visualize (with their eyes closed) letters of the alphabet at either a small size or a large size. After forming an image, the subjects heard a cue and evaluated the letter along the specified dimension (e.g., whether it has any curved lines, is vertically symmetrical, etc.). We recorded the response times on-line. We have now taken the response times and correlated them with activity in the seven regions that previously have been activated by imagery (i.e., each brain was normalized to the same mean, and relative blood flow measured in these areas, which was then correlated with RT). It is of interest, first, that approximately 25% of the subjects showed either no activation in V1 or decreased blood flow. In addition, the relative blood flow in V1 correlated $r = -.64$ with response time; subjects with less blood flow in this area required more time to respond. Moreover, blood flow in two other areas was significantly correlated with RT: the posterior parietal lobe and area 19. We presently are performing a number of stepwise multiple regression analyses, which should help us to interpret these results.

Top-down activation of V1. To resolve the controversy about top-down activation of V1, we are now finishing a study in which subjects see or visualize objects at three different sizes. We are using common objects, not letters of the alphabet, and are including the same "resting baseline" used by Roland. When Roland compared imagery to a resting baseline, he found no activation in V1; one possible reason for this null result is that subjects spontaneously visualize in this baseline condition. We are interviewing subjects about this immediately after the scan, and will compare the results with this baseline and with our standard listening baseline (i.e., we present

the same stimuli as in the actual experiment, but without the imagery instructions). If the results are as predicted, with the focus of activity shifting along calcarine cortex for different sizes, with loci very similar to those found in perception, then we will have strong evidence for the claim that imagery activates V1.

Schedule

We are in the final stages of writing the paper reporting the fMRI mental rotation results, and are just beginning to write the report of the spatial relations encoding experiments. We expect to finish writing both papers in the following quarter. In addition, we expect to finish the re-analyses of the earlier experiment and write up a brief note reporting these results. Furthermore, we expect to finish testing subjects on the three-sizes experiment, and are now in the process of designing another experiment to examine effects of different sorts of knowledge on top-down processing (this was one of the experiments in the proposal). This new experiment should be underway by the end of the next quarter.

In short, our research is progressing well, and we again thank you for your support.

Sincerely,

Stephen M. Kosslyn
Professor